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TECHNICAL MEMORANDUM

INCONSISTENCIES IN TAPE READ AND TAPE WRITE PROGRAMS ON THE I-100 IMAGE ANALYSIS SYSTEM

By

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CONTENTS

FIGURES

1. INTRODUCTION

The General Electric Interactive Multispectral Image Analysis System, Model 100 (I-100) can read tapes with Earth Resources Technology Satellite (ERTS)*, Laboratory for Applications of Remote Sensing classification system (LARSYS), and Universal formats. It can also write tapes with Universal and LARSYS formats. The computer programs used to read and write tapes were developed by different organizations and with different standards. These programs include the following five single-format programs: ERTS Tape Read, General Electric; LARSYS Tape Read, Lockheed; Universal Tape Read, Ford Aerospace; LARSYS Tape Write, Lockheed, and Universal Tape Write, Ford Aerospace.

Also included is one multiformat tape read program, the Consolidated Tape Read Program, which can read ERTS, LARSYS, or Universal format tapes.

These programs are generally compatible, but in some areas similar instructions or data are treated differently. Several interim "work-arounds" or procedures to reduce user problems have been developed.

This memorandum considers these problems and work-arounds with emphasis on the Consolidated Tape Read and Universal Tape Write Programs, the primary read and write programs for the I-100 system. Also discussed is the Procedure 1 (P-1) Image Display Program, which is a modification of the Consolidated Tape Read Program. The P-1 Image Display Program was developed to read disk images in Universal format for use in P-1 processing.

Recommendations for improving the compatibility of these programs are included.

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*Renamed Landsat in January 1975.

2. IDENTIFICATION OF PROBLEMS WITH THE CURRENT READ AND WRITE PROGRAMS

Tapes written by the I-100 will probably be used as input tapes by other computer systems or by the I-100 tape read programs. Some of the problems that occur when these tapes are read actually are caused by the tape write program. However, most of the problems discussed in this report are instances where two or more programs on the I-100 treat data in different ways. These can be either terminal inputs such as line numbers or radiance levels read from Landsat tapes. These inconsistencies make the programs more difficult to use, and may also result in the output and/or processing of erroneous data.

2.1 PROBLEMS ON VARIOUS COMPUTER SYSTEMS AND TEMPORARY WORK-AROUNDS

Problems have been found when reading or processing tapes that were originally generated on the I-100. The causes for some of these problems have been traced back to the Universal Write Program.

2.1.1 PROBLEMS

The data record size provision of the Universal format was implemented in the Universal Tape Write Program in a way that is not technically correct; this results in problems in tape read programs on the I-100 and on other computer systems.

The Universal format (ref. 1) allows multiple data sets (lines) to be stored in each physical record, but all data records must be of the same length, a maximum of 3000 data bytes and 3060 total bytes. However, multiple data sets per physical record are not required by the Universal format.

The Universal Tape Write Program is not designed to generate a tape properly if the number of lines specified by the user is not equally divisible by the number of lines in each physical record. Note that the number of lines per physical record is determined by the Universal Write Program and is a

function of the number of bytes per line and the number of channels. The user is not made aware of the number of lines per record and of its significance. As a result, the Universal Tape Write Program cannot generate a 117-line tape of a four-channel Large Area Crop Inventory Experiment (LACIE) segment. With four channels and 196 pixels on each line, it will write a tape which has four lines per physical record. This is no problem for the first 116 lines; however, at that point, the program writes two more records with repeats of lines 113-116 instead of writing line 117. When this tape is used as an input to other programs, some of the following problems can arise.

a. Production film converter (PFC) — On the PFC, the user gets an image with 124 lines; the last 8 lines contain two repeats of lines 113-116.

b. Earth Resources Interactive Processing System (ERIPS) (IBM 360/75) and Universal tape read (I-100) — On ERIPS and with Universal tape read on the I-100, the user gets 117 lines but may not realize that the last line is not line 117 but a repeat of line 113.

c. Research, Test, and Evaluation (RT&E) Utility Program (IBM 360/75) — The RT&E Utility Program on the IBM 360/75 in Building 30 only reads one line per record; if this program is used to copy an I-100 generated Universal tape, the user gets a tape which contains every fourth line of the original scene.

d. Consolidated tape read (I-100) — The Consolidated Tape Read Program reads 116 lines and the user gets an error message indicating that it expected line 117, but found line 113.

2.1.2 TEMPORARY WORK-AROUNDS

Temporary interim procedures have been developed that reduce the problems mentioned in section 2.1.1 but do not solve them. The work-around procedures follow.

a. Number of lines written — To reduce or eliminate most of these problems, when writing a tape of a LACIE segment, the best alternative is to generate a tape with 116 lines.

The first work-around attempted was to generate a tape with 120 lines, the last 3 lines of which were all zeros. This worked well with tape read programs in which the start and stop lines are specified. The normal method of generating film on the PFC of LACIE segments contains a number of defaults, including filming all lines of the tape. This works with a 116- or 117-line tape. However, when a 120-line tape (last 3 lines all zeros) was generated, the PFC went into a loop. Instead of generating 1 image, it generated 40 to 50 identical images before the operator stopped it. The PFC programmer who attempted to find the cause blamed the three lines of zeros on the tape since this was the only unusual part of the job.

The next work-around attempted was to generate 116-line tapes and accept the loss of line 117. Except for the loss of this line, no other problems have been encountered.

b. Number of lines per physical data set — The problem with the RT&E Utility Program is avoided by first reading the tape into storage interactively from an ERIPS terminal and then writing out a new tape. This new tape will only have one line per physical record and will be compatible with the RT&E Utility Program.

2.2 PROBLEMS ON THE I-100

Many of the problems that occur when writing tapes on the I-100 are the result of inconsistencies between the tape read and tape write programs. Some of these problems are compounded because both of the primary tape read programs (Consolidated and Universal) are inconsistent with each other as well as being inconsistent with the Universal Tape Write Program. Other problems are caused by inadequacies in individual programs.

2.2.1 NONSTANDARD USE OF LINE NUMBERS

The pixel and scan-line numbers for the cathode-ray tube (CRT) were standardized by General Electric as 0-511. Many programs and subroutines use these values. The Universal Read and Universal Write Programs were

written using 1-512 for the pixel and line numbers. At the present time, Universal read uses line numbers 0-511 and pixel numbers 1-512, Universal write uses 1-512 for both pixels and lines, and Consolidated tape read uses 0-511 for both pixels and lines. Thus, if the user reads a LACIE segment into the I-100 with Consolidated tape read and stores it in CRT lines 21-254 and pixels 1-392 (default values) and then wishes to write the image or theme data out onto a Universal tape, he must specify CRT lines 22-255[†] and pixels 2-393. If the segment had been read in with Universal read, then the output should be from lines 22-255[†] and pixels 1-392.

Another related problem is that a version of the Consolidated Tape Read Program was included in P-1 which has at least two differences from the original program. These lead to confusion when normal I-100 programs are run with images read from the Classification and Mensuration Subsystem (CAMS) data base. The differences are:

a. Other tape read programs create a file (TPARAM.DAT) on the disk which contains the input data from the last tape read. If the displayed image was read by the P-1 program, then the TPARAM.DAT file will contain invalid data which will be used by several other I-100 programs.

b. The default parameters for the P-1 image display will put the image on lines 20-253 while the consolidated tape read puts the image on lines 21-254 and the Universal tape read puts the image on lines 1-234. Although these defaults can be overridden, they are another source of potential confusion which can be easily eliminated.

2.2.2 UNKNOWN ZOOM FACTORS

The tape read programs provide for the specification of X_1Y_1 and X_2Y_2 values for the upper left and lower right corners of tape and CRT images with the zoom factors calculated from these inputs. It is incumbent upon the user to calculate the exact X_1Y_1 and X_2Y_2 values to give a specific zoom factor. Only the Consolidated Tape Read Program will properly notify the user

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[†]Actually lines 22-253 for 116 lines, as explained in section 2.1.1.

(figs. 1 and 2) of the zoom factor for the tape read. As delivered, the Universal Tape Read and Universal Tape Write Programs also provide for X_1Y_1 and X_2Y_2 inputs; however, the difference is that the user does not always get the zoom factor that he expects. For example, if the user desires a 4:1 zoom factor in both pixels and lines but miscalculates or mistypes the pixel number by giving a lower X_2 value for the CRT, the result will be a 3:1 zoom in pixels and a 4:1 zoom in lines because the programs permit only integer factors for the zoom. This fault has been corrected in the Universal Tape Read Program but is still present in the Universal Tape Write Program. In at least one instance, a tape write was attempted with a reduction in size of one-half in the number of pixels (392 to 196) and a reduction of one-third in the number of lines (348 to 116). The initial data had been read into lines 21-371 with a zoom factor of 3:1. For a comparable tape write zoom factor of 1:3 while writing a 116-line tape, with an offset of 1 line because of assumed line numbering, the output should be from lines 22-369. With this input to the tape write program, the recapitulation (displayed on the terminal prior to tape write) indicated that the zoom factor would be 1:3, as desired. However, the actual zoom factor was only about 1:4. Several attempts were made to write the tape from lines 22-370, 22-371, and 22-372. In each tape write, the recapitulation on the terminal said 1:3, but the tape written was about 1:4. Finally, the tape was written from lines 22-368. Although the recapitulation reported that the zoom factor would be 1:2, the zoom factor was actually 1:3. Thus, every time that the tape write recapitulation reported that the zoom factor would be 1:3, as desired, the zoom factor would be something else. When the tape write recapitulation reported that the zoom factor was 1:2, the zoom factor actually was 1:3.

2.2.3 HANDLING INPUT OF GAIN AND BIAS VALUES

The application of gain and bias values during the reading and display of digital data on the I-100 is very desirable. The expression of these values over a range of floating-point numbers is also very desirable. Normally, the tape write programs would not require a gain or bias, but the capability

```
                                                                    DATE:  8/30/78
                                                                    TIME: 13:47:40
          CONSOLIDATED TAPE READ ( VER 1.0 )                        PAGE:  2

IMAGERY DATA LOCATION   - MT0:
ON FILE NUMBER       1
IMAGERY FORMAT - 1
MOVE IMAGERY (      1 ,      1 ) (    196 ,     117 )
TO CRT       (      1 ,     21 ) (    392 ,     254 )
X-ZOOM FACTOR -     2.0000
Y-ZOOM FACTOR -     2.0000
ROTATION FACTOR :     0.00000
MATRIX TRANSFORM - N
LINEAR TRANSFORM - P
CRT-CH IMAGERY-CH         GAIN          BIAS
   1          1           2.00          0.00
   2          2           2.00          0.00
   3          3           2.00          0.00
   4          4           4.00          0.00
   5          0           0.00          0.00
PROCEED (Y/N) :
```

Figure 1.— Consolidated tape read recapitulation when reading a LACIE segment with a 2:1 zoom factor.

```
                                                                DATE:  8/30/78
                                                                TIME: 13:48:56
               CONSOLIDATED TAPE READ ( VER 1.0 )               PAGE:  2

IMAGERY DATA LOCATION  - MT0:
ON FILE NUMBER       1
IMAGERY FORMAT - 1
MOVE IMAGERY (       1 ,       1 )  (    196 ,     117 )
TO CRT       (       1 .      21 )  (    392 ,     253 )
X-ZOOM FACTOR -       2.0000
Y-ZOOM FACTOR -       1.9915
ROTATION FACTOR   :    0.00000
MATRIX TRANSFORM - N
LINEAR TRANSFORM - P
CRT-CH IMAGERY-CH          GAIN          BIAS
   1         1             2.00          0.00
   2         2             2.00          0.00
   3         3             2.00          0.00
   4         4             4.00          0.00
   5         0             0.00          0.00
PROCEED (Y/N)
```

Figure 2.— Consolidated tape read recapitulation when reading a LACIE segment with a 2:1 zoom factor where the CRT stop line was entered as 253 instead of 254.

should exist. Of the currently available tape read and write programs on the I-100, only the Consolidated Tape Read Program handles gain and bias inputs in a useful manner. The LARSYS Read Program accepts only integers for gains. Universal tape read allows floating-point numbers for gain, but no bias. Universal tape write only accepts integers for gain, but handles the inputs as neither integers nor gains. The "gain" inputs are treated as negative powers of 2. Examples of this are:

a. If the user inputs a 0, the value written on the tape will be the same as the value stored in memory.

b. If the user inputs a 1, the value written on the tape will be one-half the value stored in memory.

c. If the user inputs a 2, the value written on the tape will be one-fourth the value stored in memory.

2.2.4 STORAGE OF HEADER DATA

The Universal format tape has a 3060-byte header which contains a large amount of information about the data on the tape. When the tape is read, this header should be stored for program use and user display. The header data should also be used when writing an output tape. The Universal Read and Universal Write Programs were originally supposed to have this capability, but do not. The header record is treated as follows:

a. The Universal Read Program displays some of the header data prior to tape read, but it stores the first data record instead of storing the header.

b. The Universal Write Program has an option to write a header from stored data, but if directed to read the stored data, it will attempt to build a header from the stored data record from the last Universal tape read, and the write program will abort.

c. The Consolidated Tape Read Program has an option to store the header data on tape, but no current accepted program can read this header data.

2.2.5 HANDLING OF DATA AND PARITY ERRORS

Some tapes contain data and/or parity errors; sometimes errors are not present, but are nevertheless reported due to hardware or software failure. Most tapes contain useful data that are not significantly degraded by a few data or parity errors, particularly if the user is aware of the existence and number of these errors. The handling of data and parity errors is inconsistent within the tape read and write programs.

a. Universal Read and Universal Write Programs report and count parity errors, but still continue to read or write the tape. The user can then decide whether the data read from or written to the tape are valid for his use. In most instances, they will probably be valid.

b. The Consolidated Tape Read Program ignores all parity errors and the user is not informed of them.

2.2.6 INCONSISTENT HANDLING OF LINE NUMBERS

Line numbers on a Universal format tape are sequential numbers located at the start of each line. Most, but not all, tapes start with line 1. The I-100 user needs to know the line numbers in order to specify which lines the I-100 should read and display. Both the Universal Tape Read and Consolidated Tape Read Programs display the start and stop pixel numbers, as read from the header, and the first line number, as read from the first data record, prior to requesting inputs from the user. The Universal Write Program writes line and pixel numbers in accordance with the user inputs. The Universal Tape Read and Consolidated Tape Read Programs process line numbers differently during tape read.

a. The Universal Read Program searches for the first line it is to read and then displays that line and all subsequent lines until it has displayed the number of lines called for by the user's input. If, however, the first line of the tape is greater than the last line called for, the program will not read and display any data. It appears that the line number of only the first line of data requested and possibly prior line numbers are critical with this program.

b. The Consolidated Tape Read Program requires that each line number must be sequential from the first line number displayed to the last line number displayed. Any deviation from this sequence of line numbers terminates the tape read program, regardless of whether the line number error is a result of a bad line number on the tape itself, or whether it is an error caused by other software or hardware. On occasion, the Consolidated Tape Read Program reports a bad line number and exits. Subsequent attempts to read the tape result in reports of other line numbers being bad, but not the previously reported line number. When this happens, evidently as a result of hardware or software problems, it is impossible to read a tape with this program. Discrepancy Report 8-1046 (ref. 2) gives an example of such a case; it was impossible to read a tape even though a tape dump showed no discrepancy in line numbers.

2.2.7 LACK OF CLARITY IN THE RECAPITULATION OF AN AFFINE TRANSFORMATION TAPE READ

A very useful feature that is unique to the Consolidated Tape Read Program is the capability to do an affine transformation during tape read of a multichannel tape. The data input for this read is very clear and easy to use (fig. 3), but the recapitulation (fig. 4) is not.

```
                                                     DATE:  9/ 7/78
                                                     TIME: 10:27:23
                                                     PAGE:   4
         CONSOLIDATED TAPE READ ( VER 1.0 )

ENTER IMAGERY CHANNEL,GAIN FOR CRT CHANNEL 1
TERMINATE WITH 0,BIAS.
 1  5
 0 0
ENTER IMAGERY CHANNEL,GAIN FOR CRT CHANNEL 2
TERMINATE WITH 0,BIAS.
 2  5
 0 0
ENTER IMAGERY CHANNEL,GAIN FOR CRT CHANNEL 3
TERMINATE WITH 0,BIAS.
 3 .5
 0 0
ENTER IMAGERY CHANNEL,GAIN FOR CRT CHANNEL 4
TERMINATE WITH 0,BIAS.
 4  5
 0 0
ENTER IMAGERY CHANNEL,GAIN FOR CRT CHANNEL 5
TERMINATE WITH 0,BIAS.
 0 0
```

Figure 3.— Matrix tape read input.

```
                                                BIAS -         0.00
                                                IMAGERY                  DATE:  9/ 7/78
                                                CHANNEL        GAIN      TIME:  10:28:39
           CONSOLIDATED TAPE READ ( UNPLY.0SOIL GREENNESS  PAGE:  6
                                                LINEAR TRANSFORM - N
IMAGERY DATA LOCATION  - MT0:                   PROCEED (Y/N) :
ON FILE NUMBER      1
IMAGERY FORMAT - 1
MOVE IMAGERY (      1 ,      1 )  (    196 ,     117 )
TO CRT       (      1 ,     21 )  (    392 ,     254 )
X-ZOOM FACTOR -      2.0000
Y-ZOOM FACTOR -      2.0000
ROTATION FACTOR   :   0.00000
MATRIX TRANSFORM - Y
CRT CHANNEL - 1
BIAS -         0.00
IMAGERY
CHANNEL          GAIN
    1          0.5000
CRT CHANNEL - 2
BIAS -         0.00
IMAGERY
CHANNEL          GAIN
    2          0.5000
CRT CHANNEL - 3
BIAS -         0.00
IMAGERY
CHANNEL          GAIN
    3          0.5000
CRT CHANNEL - 4
BIAS -         0.00
IMAGERY
CHANNEL          GAIN
    4          0.5000
CRT CHANNEL - 5
```

Figure 4.— Consolidated tape read recapitulation with a matrix tape read.

3. CONCLUSIONS AND RECOMMENDATIONS

The tape read and write programs currently available on the I-100 perform their intended functions of reading and writing tapes, but are difficult to use because they contain a number of inconsistencies. These inconsistencies can often be overcome by the use of work-around procedures and by trial and error, which is an inefficient use of expensive computer systems that should not be necessary. Wherever possible, inconsistencies in the program should be eliminated. First priority should be given to modifying the Universal Tape Write Program; second priority should be given to the Consolidated Tape Read and Procedure 1 Image Display Programs. After the recommended changes are made to these programs, the Universal Read, LARSYS Tape Read, and ERTS Tape Read Programs would no longer be needed.

The following changes should be made to the appropriate tape read and write programs.

a. Modify the Universal Write Program so that it will put no more than one line of data in each physical record. This will permit writing of tapes with any number of lines (such as a LACIE tape with 117 lines) and ensure compatibility with programs on this and other computers.

b. Modify the Universal Read and Universal Write Programs so that they assume the I-100 CRT lines and pixels to be numbered 0-511.

c. Modify the Universal Write Program so that it will calculate and display zoom factors which are not integer values. The recapitulation display should show the zoom factors to four decimal places.

d. Modify the Universal Write Program to accept gains from 0.001 to 4.000.

e. Modify the Universal Write Program to read the header data stored by the Consolidated Tape Read Program.

f. Either modify the Consolidated Tape Read Program to display selected header data prior to tape read, or provide a utility program to read header data from the last tape read.

g Modify the Consolidated Tape Read Program so that it will report parity errors to the terminal and continue to read the tape.

h. Modify the Consolidated Tape Read Program so that it will report line number errors but will continue to read the tape.

i. Modify the recapitulation for the Consolidated tape read so that matrix tape read inputs will be easier to understand (fig. 5).

j. All modifications to the Consolidated Tape Read Program should also be made to the Procedure 1 Image Display Program.

k. Modify the Procedure 1 Image Display Program to create a TPARAM.DAT file.

l. Modify the Consolidated Tape Read, Universal Tape Read, and P-1 Image Display Programs so that the default display area for a LACIE size segment is lines 21-254 and pixels 1-392.

	INPUT CHAN	IMAGE CHAN 1	IMAGE CHAN 2	IMAGE CHAN 3	IMAGE CHAN 4	IMAGE CHAN 5
BIAS		0	0	0	0	0
CHAN/GAINS	1	.5	0	0	0	0
CHAN/GAINS	2	0	.5	0	0	0
CHAN/GAINS	3	0	0	.5	0	0
CHAN/GAINS	4	0	0	0	.5	0
CHAN/GAINS	5	.5	0	0	0	0
CHAN/GAINS	6	0	.5	0	0	0
CHAN/GAINS	7	0	0	.5	0	0
CHAN/GAINS	8	0	0	0	.5	0

Figure 5.– Proposed recapitulation for matrix tape read.

4. REFERENCES

1. Earth Resources Data Format Control Book (TR543). Vol. I, Rev. A., Dec. 16, 1974.

2. Hocutt, W. T.: Discrepancy Report/Program Change Authorization 8-1046, Feb. 15, 1978.